REMARKS

Claims 1-3, 7-10, 12 and 13 are pending in the present application. Claims 7-9 are withdrawn. Claims 1 and 2 are herein amended. No new matter has been entered.

Claim Rejections - 35 U.S.C. § 112

A. § 112, First Paragraph

Claims 2 and 13 were rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. Favorable reconsideration is requested.

Claim 2 has been amended to remove "and is further formed with said nickel plating layer, said zinc plating layer and said chromate treatment layer on that."

Regarding claim 13, Applicant respectfully submits that the limitation "the untreated copper foil does not have deposited nodules," is supported in the original disclosure of the application. The specification of the present application points out that the untreated copper foil having knob-like projections is "further roughening treated" by running a predetermined current through the foil for a predetermined time in an electroforming bath. Specifically, the specification states:

> the **rough surface having the knob-like projections** and the surface roughness of 2 to 4 μm is a surface of an **untreated copper foil** for bonding with a resin substrate **and is further roughening treated** by running a predetermined current through the foil for a predetermined time in an electroforming bath.

(Specification, page 7, line 21 to page 8, line 1, emphasis added.) The specification also states:

> [t]herefore, the inventors engaged in further study about factors causing transmission loss and as a result found that the **strength of the roughening** (here, "strength of **roughening treating**" defined as

> roughening current divided by roughening speed, that is, A•min/m) **for causing deposition of copper** particles on the matte side has a large influence.

(Specification, page 4, lines 2-8, emphasis added.) Based on this disclosure in the specification, one of ordinary skill in the art would understand that the untreated copper foil does not have deposited copper nodules and that the copper foil does have copper nodules after surface treatment. This is further supported by the disclosure in Wolski and the attached Document D which demonstrate the knowledge of one of ordinary skill in the art.

Wolski discloses that an untreated copper foil is subjected to surface treatment by depositing copper nodules. (Col. 3, lines 14-25.) The copper nodules are deposited on the copper foil as a result of the surface treatment for increasing the roughness. (Col. 3, lines 38-47.) The copper nodules are deposited by running an electric current through the foil. (Col. 3, lines 47-50.)

In addition, the attached Document D shows a published article in Japanese concerning surface treatment of a copper foil. Fig. 3 shows electron microscopic photos of a treated surface and an untreated surface of a copper foil. As can be seen in Fig. 3, the roughening treated copper foil has deposited copper nodules, and the untreated copper foil does not have deposited copper nodules. Thus, Wolski and the attached Document D demonstrate that one of ordinary skill in the art would understand that an untreated copper foil does not have deposited copper nodules.

The Office Action maintains that the limitation is not supported in the specification and did not consider the above-noted argument which was provided in the Amendment filed September 11, 2008, page 5. The Office Action further takes the position that the specification

does not limit the deposition of nodules to a treatment step or equate a treatment step with the deposition of copper nodules. (Office Action, page 7.)

Applicant respectfully submits that the specification explains that the deposition of copper nodules is caused by roughening treatment. The specification at page 4, lines 2-8 states:

> [t]herefore, the inventors engaged in further study about factors causing transmission loss and as a result found that the **strength of the roughening** (here, "strength of **roughening treating**" defined as roughening current divided by roughening speed, that is, A•min/m) **for causing deposition of copper** particles on the matte side has a large influence.

(Emphasis added.) Therefore, contrary to the Office Action's assertion, the limitation "the untreated copper foil does not have deposited nodules," is supported in the original disclosure.

Withdrawal of the § 112, first paragraph rejection is requested.

B. § 112, Second Paragraph

Claim 1 was rejected under 35 U.S.C. § 112, second paragraph for being indefinite. The Office Action states that the limitation "said smooth matte side" does not have an antecedent. (Office Action, page 3.) Favorable reconsideration is requested.

Applicant respectfully submits that the limitation "said smooth matte side" has proper antecedence. Claim 1 recites "a matte side surface" and that the matte side surface has "a surface shape that is smooth." Thus, the limitation "smooth matte side surface" has antecedence.

Withdrawal of the § 112, second paragraph rejection is requested.

Claim Rejections - 35 U.S.C. § 103

Claims 1-3, 10, 12 and 13 were rejected under 35 U.S.C. § 103(a) as being unpatentable over **Wolski** (US 5,834,140) in view of **Fatcheric** (US 5,679,230). Favorable reconsideration is requested.

(1) Applicant respectfully submits that Wolski in view of Fatcheric does not teach or suggest:

> An electrodeposited copper foil, comprising:
>
> a matte side surface, said matte side surface having a surface shape that is smooth with intermittently spaced ***knob-like projections***;
>
> wherein the surface roughness thereof is 2.2 to less than 4 μm, and the copper foil is ***an untreated copper foil which is not roughening treated***

as recited in amended claim 1.

The Office Action maintains that the limitation reciting that the copper foil is an untreated copper foil is a process limitation which is given **no patentable weight**, and maintains that the copper nodules deposited in a treatment process in Wolski correspond with the "knob-like projections" as recited in claim 1. (Office Action, page 4.)

However, as previously pointed out, the Office Action incorrectly gives no patentable weight to the limitation "untreated copper foil." The MPEP states that:

> The structure implied by the process steps should be considered when assessing the patentability of product-by-process claims over the prior art, especially where the product can only be defined by the process steps by which the product is made, or where the manufacturing process steps would be expected to impart distinctive structural characteristics to the final product.

MPEP § 2113, citing *In re Garnero*, 412 F.2d 276 (CCPA 1979).

The Office Action appears to assume that the only structural difference between a treated and an untreated copper foil is the surface roughness characteristic. However, an untreated copper foil also does not have deposited copper nodules. Deposited copper nodules are the result of a treatment process. Wolski at col. 3, lines 14-24 states:

> in order to provide characteristics necessary for a copper-clad laminated board, the untreated copper foil 4 is passed through the treater as shown in FIG. 2 to carry out an electrochemical or chemical surface treatment continuously. Among these ***treatments***, there is a ***process of depositing copper [n]odules*** on the surface of the foil for enhancing bonding strength of the foil when it is laminated to an insulating resin substrate. This process is called to as a ***bond enhancing treatment***. The copper foil subjected to the above treatments is called a ***treated copper foil*** 8 and can be used for a copper-clad laminated board.

(Emphasis added.) For additional support, the attached Document D at Fig. 3 demonstrates that a roughening treated copper foil has deposited copper nodules and that an untreated copper foil does not have deposited copper nodules.

The copper nodules are the result of a treatment process, and thus, the cited copper foil having deposited copper nodules in Wolski is structurally distinguishable from an untreated copper foil as recited in claim 1.

The Office Action takes the position that the limitation "untreated copper foil" does not limit the claim to any particular treatment, and thus, a "copper foil can be regarded as an untreated copper foil ... if it was not formed with a particular additive or washed in a particular manner." (Office Action, page 8.)

Claim 1 has been amended to recite that "the copper foil is an untreated copper foil which is not roughening treated." Thus, the untreated copper foil has been limited to a copper foil that has not been roughening treated. Since an untreated copper foil which has not been roughening treated does not have deposited copper nodules, the deposited copper nodules of Wolski cannot correspond with the recited knob-like projects.

Wolski does not teach or suggest an untreated copper foil, which has not been roughening treated, having knob-like projections. Therefore, Wolski does not teach or suggest the elements as recited in claim 1.

(2) Applicant respectfully submits that Wolski in view of Fatcheric does not teach or suggest a matte side surface of a copper foil having a surface shape that is smooth with "intermittently spaced knob-like projections" as recited in claim 1.

The Office Action acknowledges that Wolski does not teach this feature. (Office Action, page 4.) The Office Action cites Fatcheric for teaching this feature. Specifically, the Office Action takes the position that the nodules on the copper foil as seen in Fig. 2 are broadly interpreted to be intermittently spaced. (Office Action, page 5.)

However, as seen in Fig. 2, the nodules merely have different sizes and are formed continuously without any spacing. Thus, the nodules cannot be considered "intermittently spaced." This is apparent from a comparison between Fig. 2 of Fatcheric and Figs. 1-3 of the present invention.

Moreover, the fine nodular metal deposit in Fatcheric cannot correspond with the recited intermittently spaced knob-like projections because the fine nodular metal deposit in Fatcheric is the result of a treatment process. Fatcheric states:

> In one aspect, the invention is an electrolytically formed copper foil ... which has been ***electrolytically treated*** on the matte side ***to deposit micro nodules*** of a metal or alloy, preferably copper or a copper alloy, which do not increase the measured roughness, but nevertheless do increase adhesion to a substrate.

(Col. 3, lines 11-17, emphasis added; *See also* Abstract.) As stated above, an untreated copper foil, which has not been roughening treated, does not have deposited copper nodules. Therefore, Wolski in view Fatcheric does not teach or suggest "intermittently spaced knob-like projections."

(3) Applicant respectfully submits that Wolski in view Fatcheric does not teach or suggest "wherein the untreated copper foil does not have deposited nodules" as recited in claim 13.

The Office Action states that the claim does not further structurally limit the product and that it would have been obvious to omit the copper nodules if enhanced bonding strength is not desired. (Office Action, page 7.) The Office Action did not consider or respond to Applicant's argument regarding claim 13 which was presented in the Amendment of September 11, 2008. Applicant requests consideration of the argument regarding claim 13. The argument is repeated below.

Claim 13 recites that the copper foil does not have deposited copper nodules which is a ***structural limitation***. In addition, if the copper foil in Wolski omits the deposited copper nodules, as alleged by the Office Action as obvious to one of ordinary skill in the art, then the

copper foil would not have "knob-like projections" as defined by the Office Action. The Office Action cites the copper nodules of Wolski as corresponding to the knob-like projections as recited in claim 1. (Office Action, page 4.) Thus, if the copper nodules are omitted, then the copper foil no longer has "knob-like projections."

For at least the foregoing reasons, claims 1-3, 10, 12 and 13 are patentable over the cited references. Accordingly, withdrawal of the rejection of claims 1-3, 10, 12 and 13 is hereby solicited.

In view of the aforementioned amendments and accompanying remarks, Applicant submits that the claims, as herein amended, are in condition for allowance. Applicant requests such action at an early date.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicant's undersigned attorney to arrange for an interview to expedite the disposition of this case.

If this paper is not timely filed, Applicant respectfully petitions for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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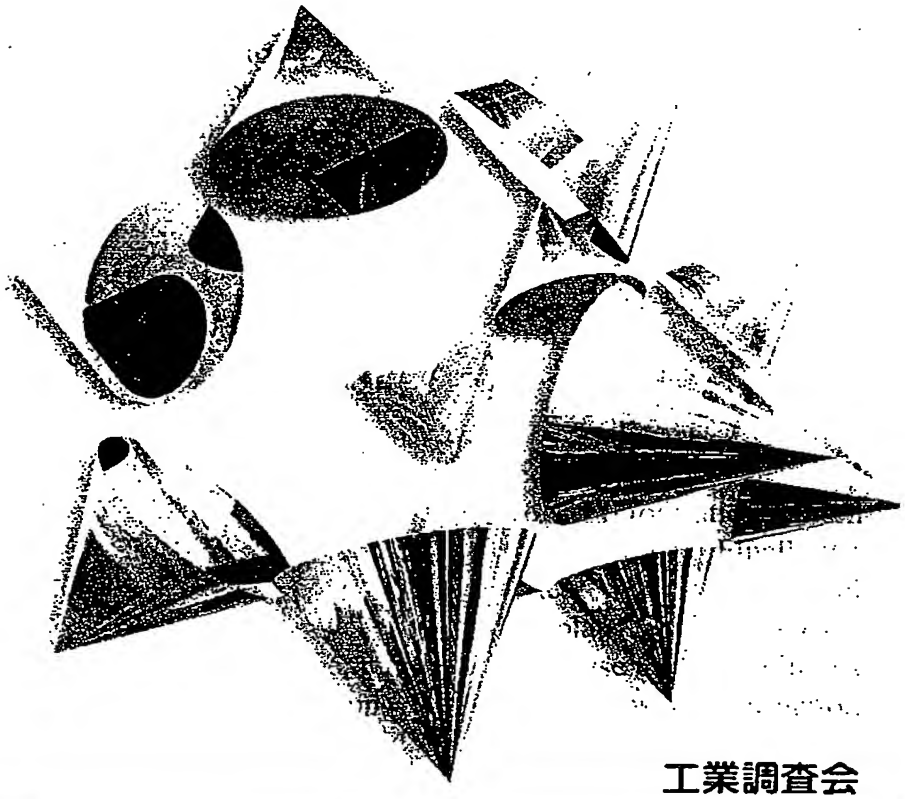
AGM/adp/ttw
Attachment: Document "D" - Japanese Article

図解 最先端 表面処理技術のすべて

関東学院大学表面工学研究所 編



工業調査会

銅箔の表面処理

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**関東学院大学 工学部
高橋 勝*，山下 嗣人**

プリント配線板は携帯電話やパソコン，ディスプレイなどの電気電子機器の配線回路として使用されています。このプリント配線板は，まず銅箔とプリント樹脂基材を張り合わせ，銅張積層板(CCL：Cu Clad Laminate)を作製し，その後，銅箔の不要部分を酸やアルカリの腐食液(エッチャント)で除去して，導体回路を形成しています。本稿では，プリント配線板に用いられる銅箔の概要と銅箔に施される表面処理例について解説します。

電解銅箔の製造法

プリント配線板に使用される銅箔の製造法には，銅板を目標厚みまで機械的に引き延ばす圧延銅箔と，円筒状の金属ドラムカソードを回転させながら，目標厚みまで電解析出により製造する電解銅箔があります。電解銅箔は，プリント配線板の全使用量の約90％を占めており，プリント配線板に使用される代表的な銅箔です。

図1に電解銅箔の製造方法の模式図を示します。この電解銅箔の製造工程は銅箔をめっき法で製造する電解工程と，銅箔の表面に必要な機能を付与する表面処理工程で構成されます。表面処理工程は樹脂基材との接着強度を向上させるために銅や銅合金の粗化粒子を形成する粗化処理と，銅箔に耐熱性，耐薬品性および耐錆性を付与する各種金属のめっきやシランカップリング剤などの有機処理を施す表面処理とからなっています。

電解工程

電解銅箔は円筒状のドラムカソードを使用し回転させながら，硫酸銅を主成分とした電解液中で目標厚みまで電気めっきを施し，それを連続的に巻き取ることにより製造されます。一般的な銀めっきなどと比較し，数十倍の高電流密度(50～100A/dm^2)で行われ，アノードには，不溶性電極として鉛電極や酸化イリジウム電極を使用しています。これは，銅アノードを使用した場合に発生する銅の不働態化や銅アノードの溶解による極間距離の変化を避けて，常に一定の槽電圧と極間を保持するためです。

電解工程で巻き取られた銅箔は，2つの異なる面を有しています。ドラムカソードに接していた光沢のある電極面(シャイニー面とも呼ばれています)と，電解液に接していた光沢のない成長自由面(マット面とも呼ばれています)です。シャイニー面は，ドラム表面形状のレプリカとなっているため，めっき条件などの影響を受けませんが，マット面は析出形状を反映した形状となります。この結晶の析出形状を制御する因子には，①硫酸銅濃度，②硫酸濃度，③添加剤種類，④添加剤濃度，⑤電解液温度および⑥電解液流量などがあります。また，電解銅箔の機械的性質(引張り強さ(最大破断強度)，伸び)も，添加剤の種類や濃度に大きく依存しており，これらの因子を管理することにより，電解工程において銅箔の析出形状と機械的性質

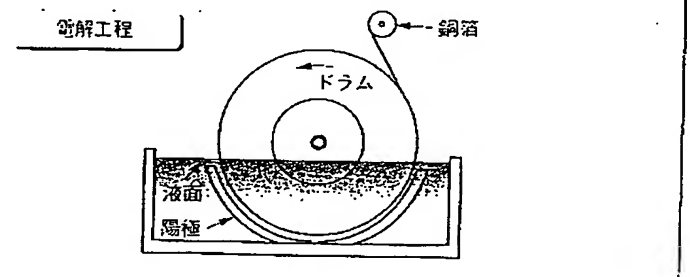

図1　銅箔の製造工程

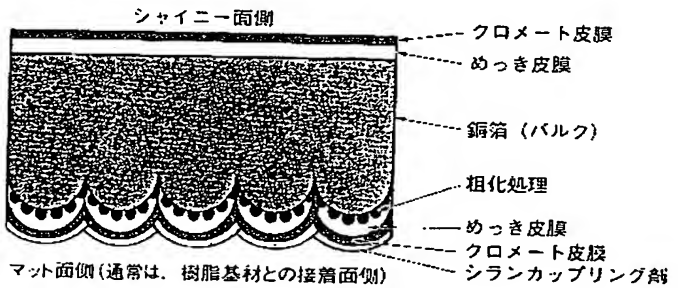

図2　銅箔の表面処理構造

を制御しています。

表面処理工程

電解工程で巻き取られた銅箔のみでは，銅張積層板やプリント配線板として要求される性能を満足できません。そこで，多数の槽を順次通過させることにより，銅箔に必要な性能が付与されます。この工程を表面処理工程と呼んでいます。

図2に銅箔の表面処理構造のプリント模式図を示します。とくに，プリント樹脂基材と接着する接着面側は，デンドライト状の銅めっきを施す粗化処理，亜鉛（合金）めっき，クロメート処理およびシランカップリング剤などの有機処理からなっています。表1は，表面処理で銅箔に付与される機能と表面処理との関係をまとめて示したものです。

粗化処理は，硫酸銅溶液を用い，水素ガスの発生を伴う限界電流密度以上の電流密度で樹枝状の銅を形成する工程と，限界電流密度未満の電流密度で樹枝状の銅の表面をめっきで覆う工程の組み合わせによって形成されます。図3に走査型電子顕微鏡（SEM）で観察した硫酸銅めっきによる粗化粒子の形成例を示します。このような凹凸の形状にすることで，銅箔はアンカー効果により樹脂基材と強固に接着しています。

粗化処理後の銅箔に耐熱性，耐錆性および耐薬品性などの機能を付与するために，銅箔のシャイニー面とマット面にCr，Zn，Niなどの金属をめっきします。これらの析出状態はめっき条件（金属イオン濃度，電流密度，温度，pHなど）によって制御されています。また，単独ではなく複数の金属の合金としてめっきする場合もあります。これらのめっきは用いられる樹

脂基材の種類や使用環境によって選択されます。また，このめっきで用いられる金属は，プリント配線板の配線を形成する際の腐食液で除去できないと，プリント配線板の絶縁不良や，配線の形状に問題を引き起こしたりするため，腐食液で除去できる金属が好まれています。

表1　表面処理で付与される機能と表面処理との関係

	接着強度	耐薬品性	耐熱性	耐錆性
粗化処理	○	○		
めっき皮膜		○	○	○
クロメート処理		○		
有機処理(シランカップリング剤)	○			

(注) ※効果のある項目に○印を記した

その後，シランカップリング剤X Si(OR)$_3$ (X：エポキシ基やアミノ基などの機能性官能基，R：メチル基またはエチル基)などの有機処理を施します。シランカップリング剤は，一分子中にシリルエステル基(Si OR)と機能性官能基を有しており，一方の末端基であるシリルエステル基は加水分解してシラノール(Si-OH)基となり，その後，脱水縮合反応により金属表面の水酸基と結合して安定なSi-O-Me結合(Me：金属またはSi)を形成します。他方の末端基である機能性官能基は塗料や樹脂母材と反応することが知られています。このため，樹脂基材との濡れ性の改善，機能性官能基による樹脂基材との共有結合の形成などの作用によって，樹脂基材との高い接着強度が得られます。しかし，この処理はシランカップリング剤の種類や濃度，溶液のpH，熱処理条件などによって，樹脂基材との接着強度が大きく異なるため，樹脂基材の種類に応じ，樹脂基材ともっとも高い接着強度が得られる最適な処理条件の選択が必要となっています。

最後に，銅箔は携帯電話やパソコンなどのIT機器やデジタル家電などのエレクトロニクス製品で用いられており，これらの製品の発展とともにその使用量を大きく伸ばしてきました。近年，エレクトロニクス製品の高機能化・高性能化が顕著となっており，それに伴ないプリント配線板の高密度配線化・微細配線化が進んでいます。この動きに対応するため，銅箔には接着面側の粗さのロープロファイル化(低粗度化)，それに伴なう接着強度の低下の改善，銅箔の厚みの薄膜化などが求められており，これらの問題を解決するために，高度な表面処理技術が必要となっています。

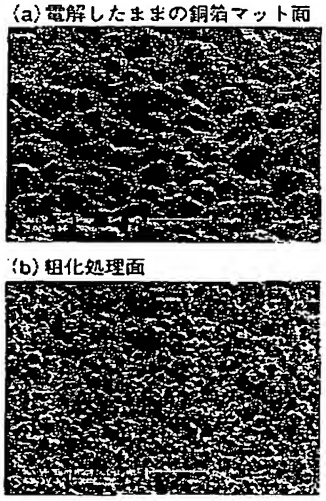

図3　粗化処理前後の表面形状の変化

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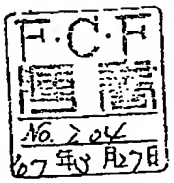

図解　最先端 表面処理技術のすべて

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